Blue Horizons (BH) II
2008 Final Report

We make a difference...

one idea at a time

Center for Strategy and Technology

Col John Geis

Today's Vision – Tomorrow's Capabilities

Overview

- A-8 Tasking and Background
- Alternate Futures and Methodology
- Operational Analysis
- Summary of Underlying Technologies
- 2008 Findings and Conclusions

A-8 Tasking and Background

Center for Strategy and Technology
Air University, Maxwell Air Force Base, Alabama

Today's Vision – Tomorrow's Capabilities

Background

- ***Blue Horizons is an Outgrowth of AF 2025 Study***
- ***Air Force 2025*** study conducted in 1995-96
  - $1.5M Effort, 286 participants
  - Charter: Identify concepts, capabilities and technologies USAF requires to remain dominant
  - Intent: Repeat every five years (not accomplished)
- ***Blue Horizons*** – AF/A8 long range planning effort
  - Results briefed to and approved by CSAF
  - Results to be meshed with QDR/POM cycles

A8 Tasking for Blue Horizons II (2008)

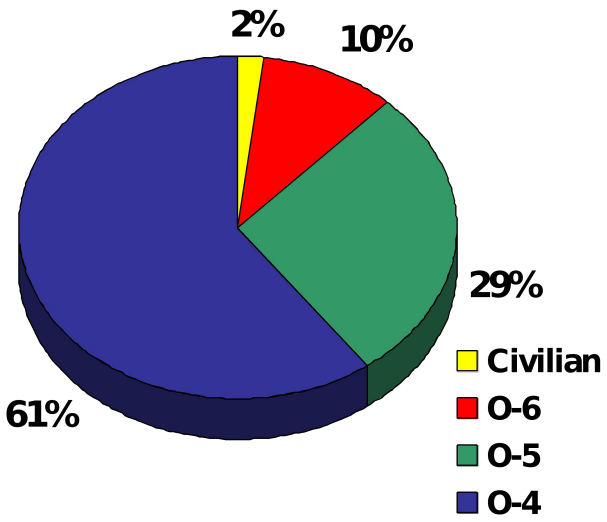
Specified Task

"…develop a prioritized list of concepts and their key enabling technologies that the U.S. Air Force will need to maintain the dominant air, space and cyber forces in the future"

***Implied Task:* Determine how we can leverage a targeted investment today to position the USAF to address a broad set of possible challenges in 2030**

The Researchers

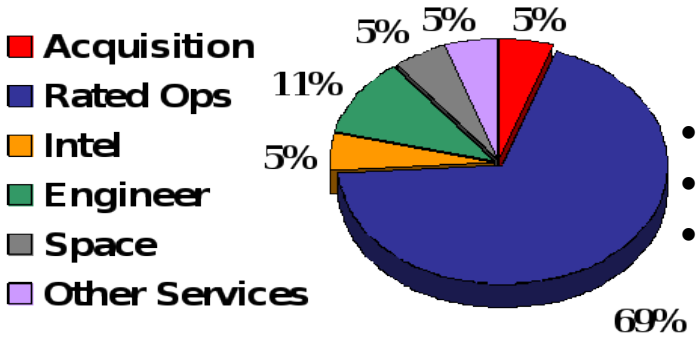
PARTICIPANTS



49 students & 7 faculty

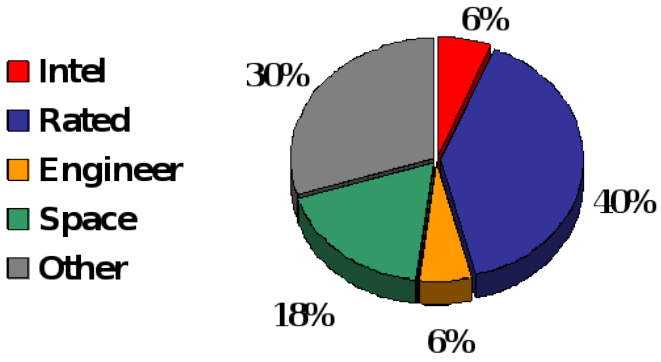
SERVICE EXPERIENCE

Air War College



Tasks:
- Alternate futures
- Operations analys
- S&T analysis

Air Command and Staff College

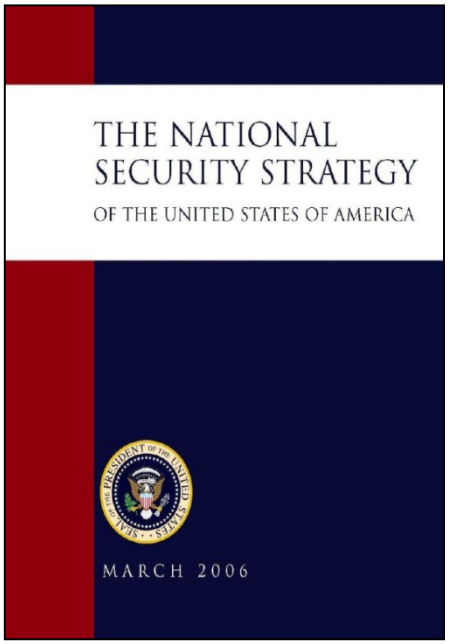


Tasks:
- Futures Technology
- CONOPS
- Forecasts

…a blue-suit, operational view of future technology

2030 Alternate Futures:

Rooted in National and AF Guidance



"The United States must...Strengthen alliances to defeat global terrorism and work to prevent attacks against us and our friends...(and)...work with others to diffuse regional conflicts..."

Alternate Futures: Failed State and Jihadist Insurgency

"Our strategy seeks to encourage China to make the right choices for its people, while we hedge against other possibilities."

Alternate Future: Peer China

"Russia has great influence not only in Europe and its own immediate neighborhood, but also in many other regions of vital interest to us...(but) recent trends point to a diminishing commitment to democratic freedom and institutions."

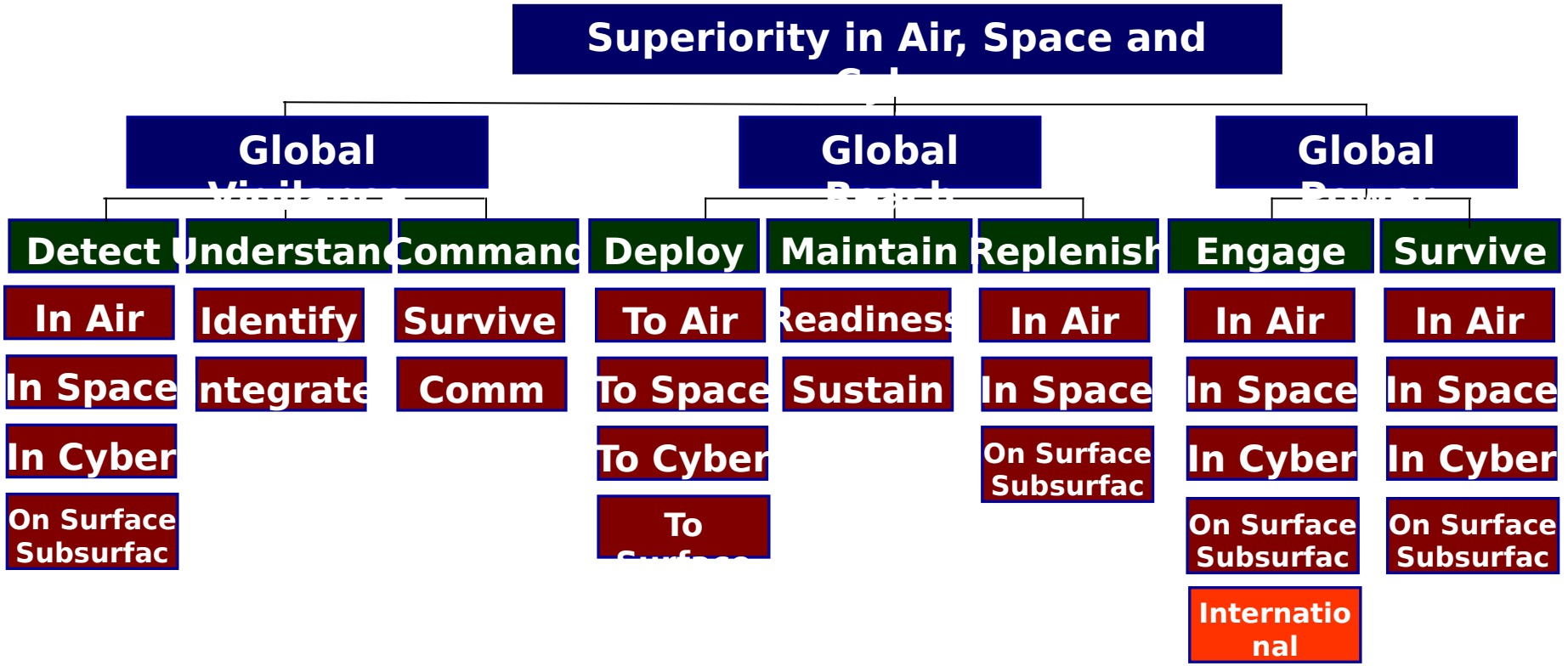
Alternate Future: Resurgent Russia

BH 2030 Research Methodology
Quantitative Analysis

- Model equation:

$$S(\mathbf{x}) = \sum_{j=1}^{m} \frac{1}{m} [\sum_{i=1}^{n} \omega_{im} u_i]$$

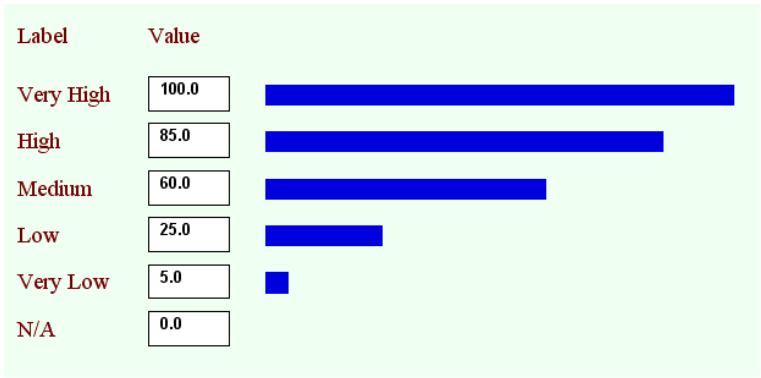
- Concepts scored across all four alternate futures using the following value model:



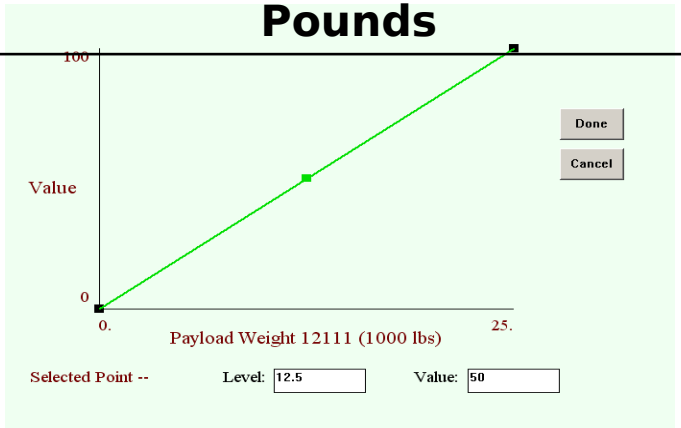
BH 2030 Research Methodology
Quantitative Analysis

- Capability curves were created for each of 47 significant AF military capabilities in each scenario.
  - Values curves do vary by scenario
- Each of the 58 concepts were then scored using these capability functions.

Non-linear Step Function for Combat Aircraft Survivability (Resurgent Russia Scenario)



Linear Mathematical Function for Space Launch Payload Capacity: ω=0.004X, where X=Payload in Pounds



BH 2030 Research Methodology
Quantitative Analysis

- Capability Scores were then Multiplied by Value Scores
  - Value Scores were Determined by a Separate Set of Models – One for Each Future
- Structure of the Model is the Same for Each Scenario, but the Weights are Different
  - Values at each level sum to 100 percent
  - Weights of model components vary by scenario

Grounded in Reputable Scholarship

BH 2030 Research Methodology
Quantitative Analysis

- Technology Model
  - 172 mutually exclusive but comprehensively exhaustive enabling technologies underpin the 58 concepts

- Technologies scored points based on the value of the concept(s) they underpinned.
  - Model is a 172 x 58 x 4 three-dimensional matrix

  - Fundamental Model Equati $$T(x)=\sum_{\beta=1}^{\kappa}\frac{1}{\alpha_\beta}\{\sum_{y=1}^{m}\frac{1}{m}[\sum_{i=1}^{n}w_{im}\mu_i]\}$$

- Output: A prioritized list of enabling technologies of greatest value to the AF

7,501,952 Components in the Model Reduced to a Prioritized List

Blue Horizons Alternate Futures

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Air University, Maxwell Air Force Base, Alabama

Today's Vision – Tomorrow's Capabilities

Peer China

- Why China?
  - In 2030, world's largest country in terms of population and GDP
  - A regional military peer with a limited—but growing—global power projection capability
  - A nation whose future strategic direction is still uncertain, but one who also has many strategic options

Plausible History

Economy passes U.S. in PPP

18th Plenum for Chinese Leadership – Change

Begins to import large quantities of foodstuffs

Approximate date for production start of 1st CVBG

2010 — 2015 — 2019

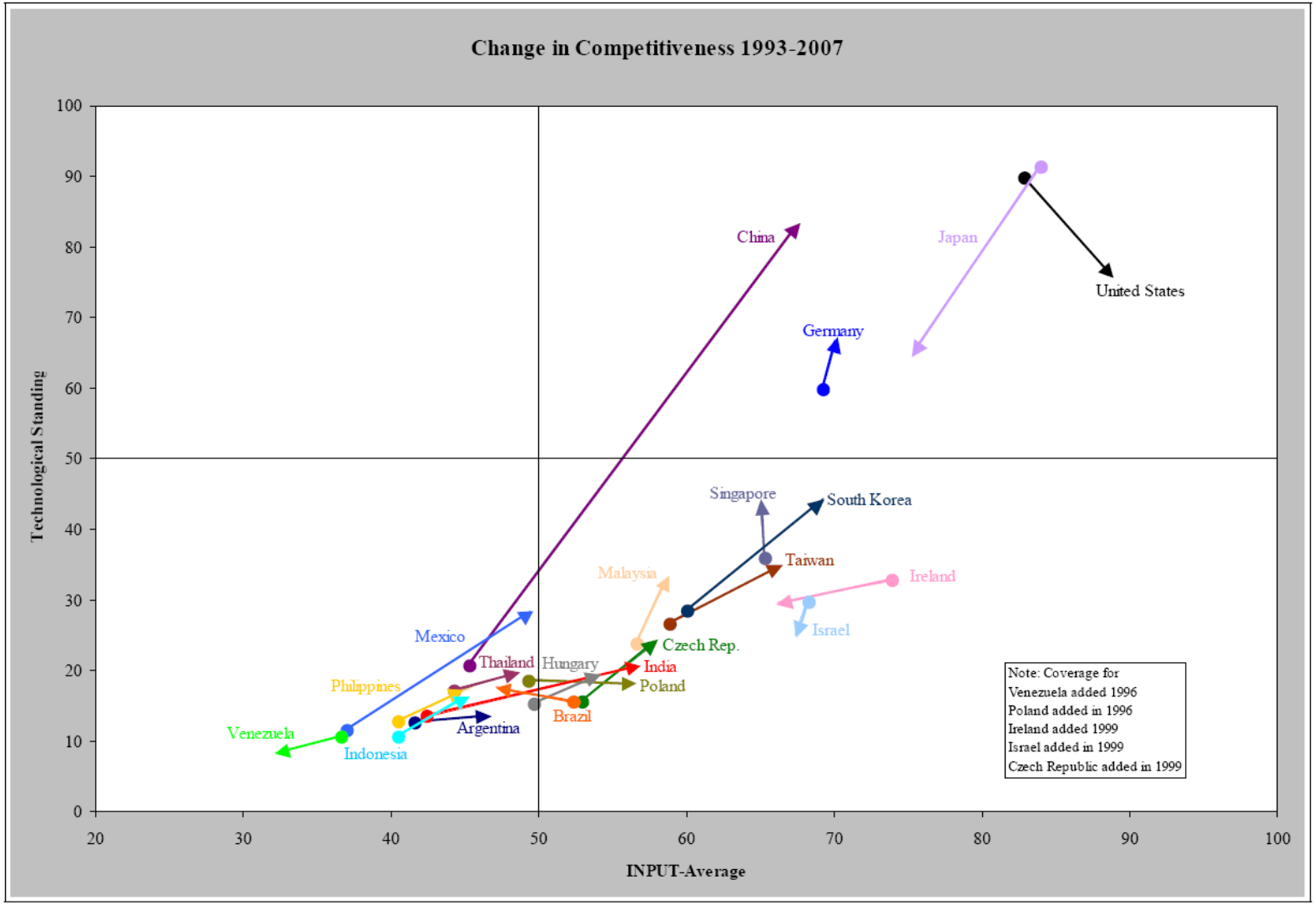
Passes U.S. in actual GDP

20th Plenum – Chinese Leadership Change

Reaches (at minimum) Regional Peer Status

2020 — 2025 — 2030

Chinese Innovation



China in 2030

Causality

- Greater GDP than US
- Regional power peer, but projection can be challenged beyond Indian & Pacific
- Huge demand for imported energy and foodstuffs
- Environmental decay

- Taiwan issue
- Seeks “Harmonious World”

Impact

- Hegemonic shift in Asia
- Deny basing access/ naval projection to 2nd island chain…and challenge beyond
- Potential source of internal friction…external conflict
- Increased cost of production, healthcare, cleanup
- Increased freedom of action
- Domestic instability or resource constraints could lead to hegemonic conflict

Able to dominate Asia if it wishes…

Required USAF Capabilities

- Counter interior line advantages at great distances against:
  - Sophisticated integrated defense systems on land/at sea/in air
  - Cruise and ballistic missiles
  - Directed energy and information weapons

- Requires:
  - Long range systems—China could initially deny penetration inside second island chain (Guam to Northern Australia)
  - Protection and rapid reconstitution in cyberspace of both civilian and military infrastructure
  - Large, fast lift capability
    - May become a race to see who can close first
  - Survivable basing against hypersonic missiles
    - Dispersal, lily pad, and/or hardening
  - Protection and rapid reconstitution of critical space capabilities
    - Awareness, debris and radiation mitigation, rapid launch

Range…Cyber…Lift…ISR…Force Protection…Space

Failed State
Case Study – Nigeria

- Why Nigeria?
  - Key US oil supplier; active insurgency (MEND) attacking oil infrastructure
  - Top 20 world economy
  - Disproportionate influence on regional stability – Nigeria's failure can ignite wars between and within neighboring countries
  - Largest population in Africa
  - Growing Islamic population in the North follows Shari'a Law
  - Rampant institutional corruption; haven for transnational criminal enterprises

Jihadist Insurgency
Case Study – Middle East

- Why the Middle East?
  - Disruption to vital oil resource
  - Wealth and military capability in hands of Jihadists → disastrous
  - Muslim holy cities must not fall into hands of radical Muslims
  - Regional power balance - Sunni counterweight to Shiia Iraq and Iran
  - Substantial population growth with poor outlook in labor economics fostering discontent
  - Existing low level insurgency – strong potential for expanded religious, ethnic, and tribal conflict

Resurgent Russia

Why Russia?

- Key supplier of world energy
- Major world economy – high potential for rapid increase via wealth from hydrocarbon exports
- Transitioning philosophy – Communism, ~ Democracy, to autocracy?
- NATO expansion – regional tensions increasing
- Rising nationalism and xenophobia
- Large nuclear stockpile with modernizing conventional capabilities
- Demands a role on the world stage

Blue Horizons 2008 Operational Analysis

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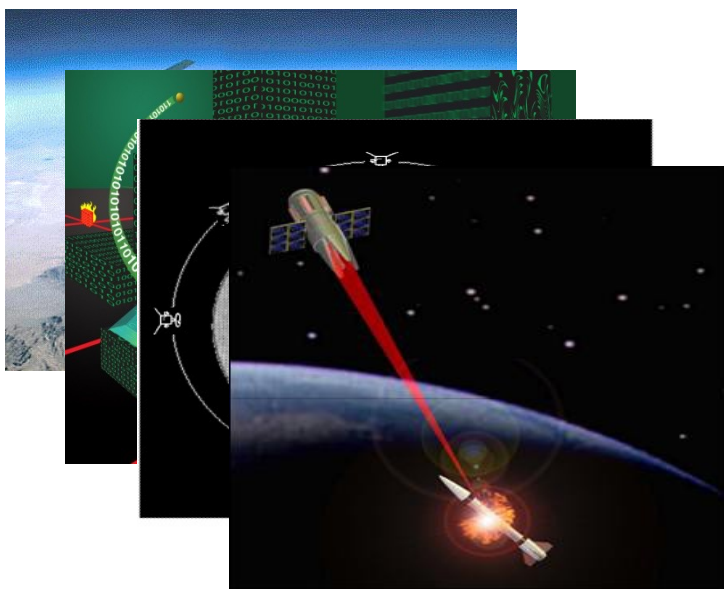
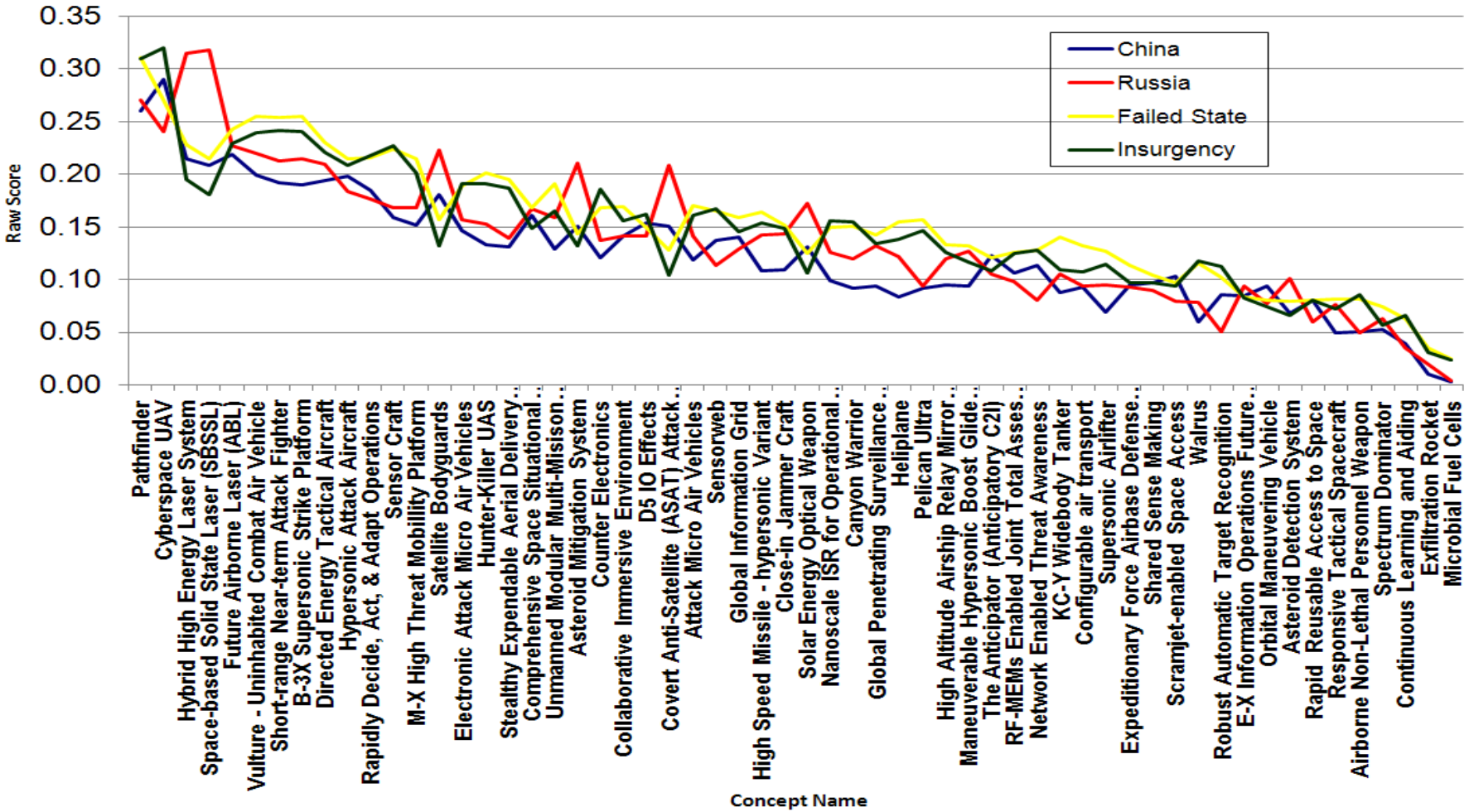
Today's Vision – Tomorrow's Capabilities

Summary of 58 Concepts

- Notional systems (in most cases) representing specific capabilities
- Some top concepts are worth exploring for production
- Concepts provide a vehicle for evaluating enabling technologies



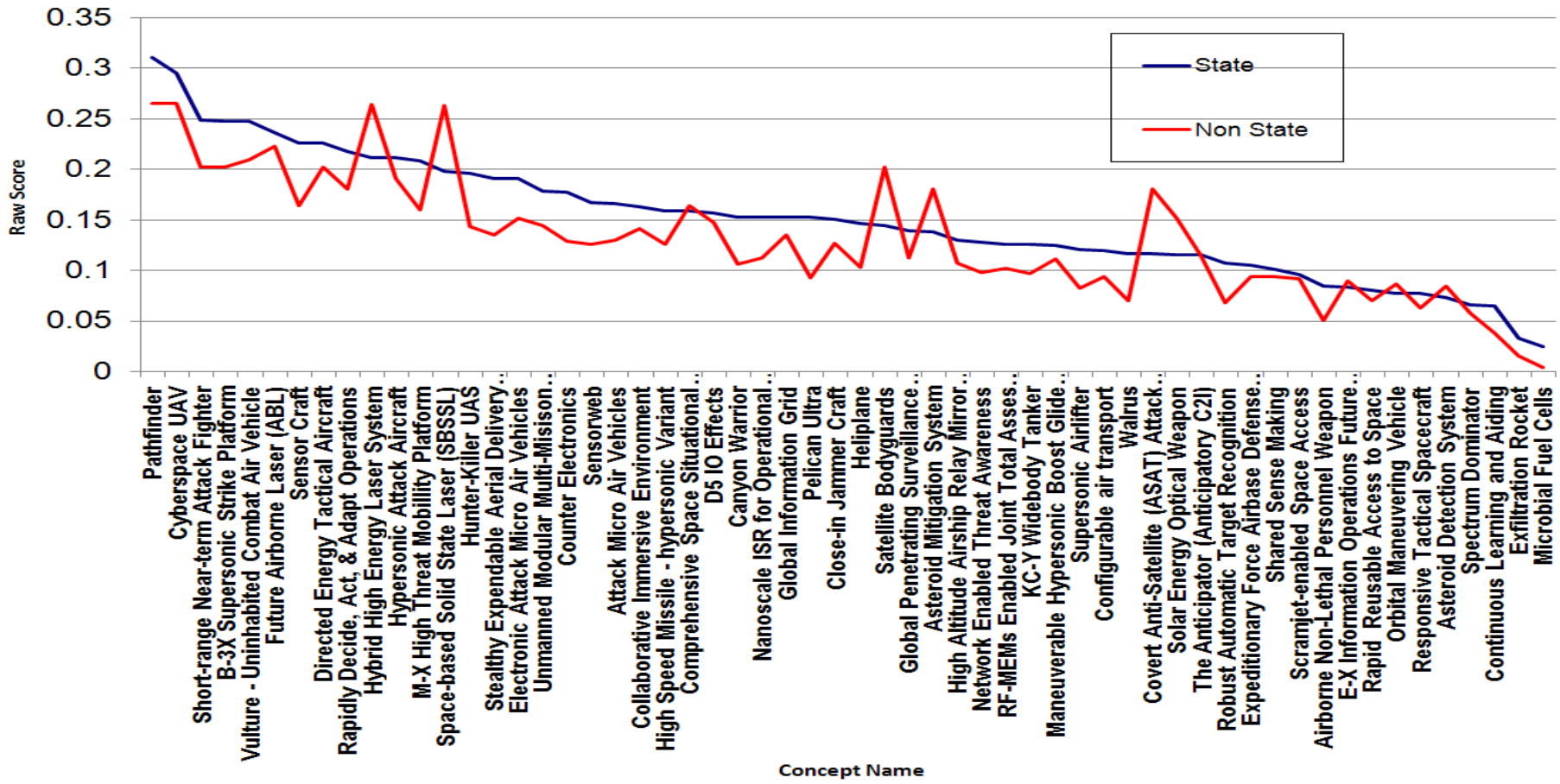
Rank Order of Concepts
Across All Alternate Futures



Ranking of key concepts is relatively constant across alternate futures

Rank Order of Concepts

China/Russia vs Insurgency/Failed State



Offensive Space Capability Differentiates Futures

Top 10 Concepts
Across All Futures

Pathfinder

Cyberspace UAV

Hybrid High Energy Laser System

Space-based Solid State Laser (SBSSL)

Future Airborne Laser (ABL)

Vulture - Uninhabited Combat Air Vehicle

Short-range Near-term Attack Fighter

B-3X Supersonic Strike Platform

Directed Energy Tactical Aircraft

Hypersonic Attack Aircraft

- *41 Enabling Technologies*
- *Integrated multi-spectral sensors for threat acquisition*
- *Flight systems incorporate self-diagnosis and repair*
- *Multiple technique jamming devices and arrays – arrays embedded in aircraft skin*
- *Able to control jamming swarms and coordinate other engagements through battle management system*

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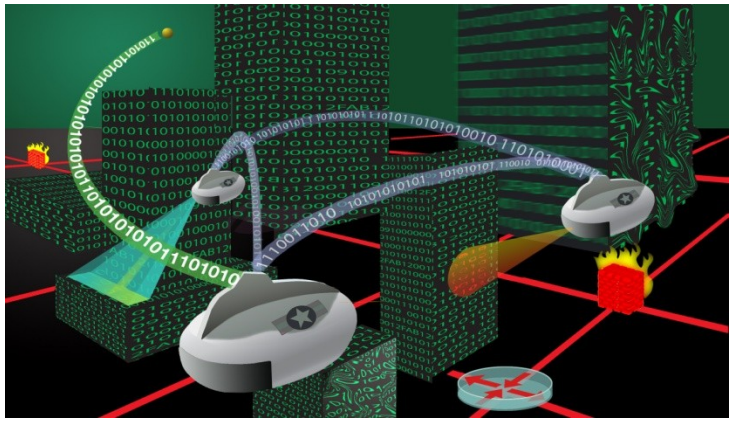

- *11 Enabling Technologies*
- *A virtual "vehicle" in a virtual world*
- *Guarantees survivability of cyberspace in a high threat environment*
- *Provides a dynamic view of cyberspace*
- *Trusted integrated cyber-defense for AF and DOD networks*

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Across All Alternate Futures

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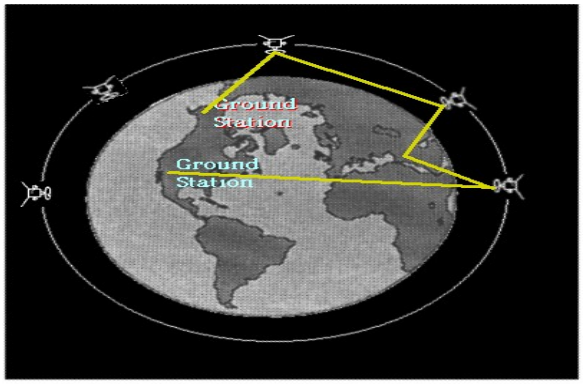

- *13 Enabling Technologies*
- *Space-based mirrors enable nearly unattenuated laser propagation through space*
- *Mirror positioning would enable rapid DE attack of any unobstructed (by weather) target (air, ground, space) in real-time*
- *Able to destroy soft and medium targets*
- *Able to degrade some hard targets (e.g., burn wheels of armored vehicles, burn off tread from tanks) where soft spots exist*

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Across All Alternate Futures

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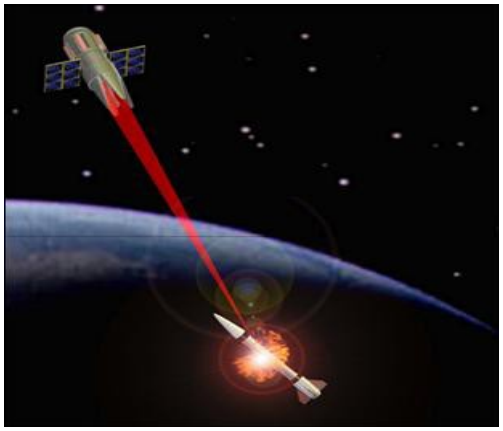

- *12 Enabling Technologies*
- *Medium range effectiveness against missiles or near-Earth objects.*
- *Low-effectiveness against ground targets*
- *Solar array charges capacitors that can then discharge energy against targets. When depleted, recharging is required.*
- *24 satellite constellation is envisioned with 4 orbits*

Top 10 Concepts
Across All Alternate Futures

Pathfinder

Cyberspace UAV

Hybrid High Energy Laser System

Space-based Solid State Laser (SBSSL)

Future Airborne Laser

Short-range Near-term Attack Fighter

B-3X Supersonic Strike Platform

Directed Energy Tactical Aircraft

Hypersonic Attack Aircraft

- *19 Enabling Technologies*
- *Global combat radius with cruise speeds of over 550 kts. Max mission distance: 80,000 NM*
- *Able to damage moderately hard targets at close range; soft targets at up to a few hundred kilometers*
- *Max cruise altitude similar to modern airliners*

Top 10 Concepts
Across All Alternate Futures

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Cyberspace UAV

Hybrid High Energy Laser System

Space-based Solid State Laser (SBSSL)

Future Airborne Laser (ABL)

Vulture UAV

Short-range Near-term Attack Fighter

B-3X Supersonic Strike Platform

Directed Energy Tactical Aircraft

Hypersonic Attack Aircraft

- *18 Enabling Technologies*
- *Long-range combat radius with 2 hours loiter*
- *Self-Deployable*
- *Capable of carrying internal weapons in two bays – each can carry one large weapon, several SDBs or a jamming payload*
- *Capable of carrying ISR payloads*
- *Capable of high-altitude flight*
- *Requires standard airbase runway*
- *Supersonic speed capabilities*

Top 10 Concepts
Across All Alternate Futures

Pathfinder

Cyberspace UAV

Hybrid High Energy Laser System

Space-based Solid State Laser (SBSSL)

Future Airborne Laser (ABL)

Vulture - Uninhabited Combat Air Vehicle

hort-Range, Near-Term Fighter

B-3X Supersonic Strike Platform

Directed Energy Tactical Aircraft

Hypersonic Attack Aircraft

- *5 enabling technologies*
- *Combat radius: 500 NM*
- *Speed: Cruise and dash above Mach 1*
- *Payload: Up to 14,000 pounds*
- *Armaments: Gun (25 mm); Air-to-air missiles including AMRAAM and Air-surface missiles, HARM, JSOW, and most bomb variants up to 2000 pounds*
- *Able to simultaneously fuse data from all on-board sensors*

Today's Vision – Tomorrow's Capabilities

Top 10 Concepts Across All Alternate Futures

Pathfinder

Cyberspace UAV

Hybrid High Energy Laser System

Space-based Solid State Laser (SBSSL)

Future Airborne Laser (ABL)

Vulture - Uninhabited Combat Air Vehicle

Short-range Near-term Attack Fighter

-3X Supersonic Strike Platform

Directed Energy Tactical Aircraft

Hypersonic Attack Aircraft

- *19 enabling technologies*
- *Long-range unrefueled combat radius*
- *Supersonic speeds*
- *Medium bomber payload*
- *Armaments: Bombs and self-defense weapons*
- *Able to simultaneously fuse data from all on-board sensors*
- *Low observable*

Top 10 Concepts
Across All Alternate Futures

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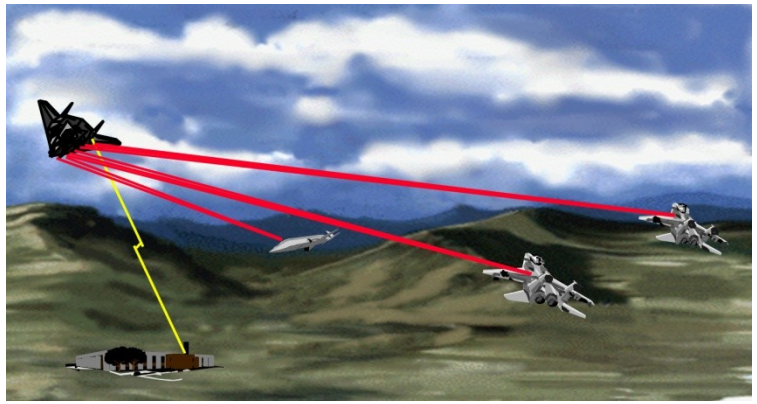

- *23 Enabling Technologies*
- *Medium energy tactical laser (not ABL class)*
- *HPM attack capability*
- *Precision strike at speed of light*
- *Unlimited magazine as long as fuel is on board – effective against medium-hard targets at short range.*
- *Combat radius is nominally in the same class as a medium fighter*

Top 10 Concepts Across All Alternate Futures

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B-3X Supersonic Strike Platform

Directed Energy Tactical Aircraft

Hypersonic Attack Aircraft

- *19 Enabling Technologies*
- *Combat Radius: Global*
- *Speed: Mach 6+*
- *Medium payload*
- *System can also launch trans-atmospheric vehicles and launch micro-satellites into low earth orbit*

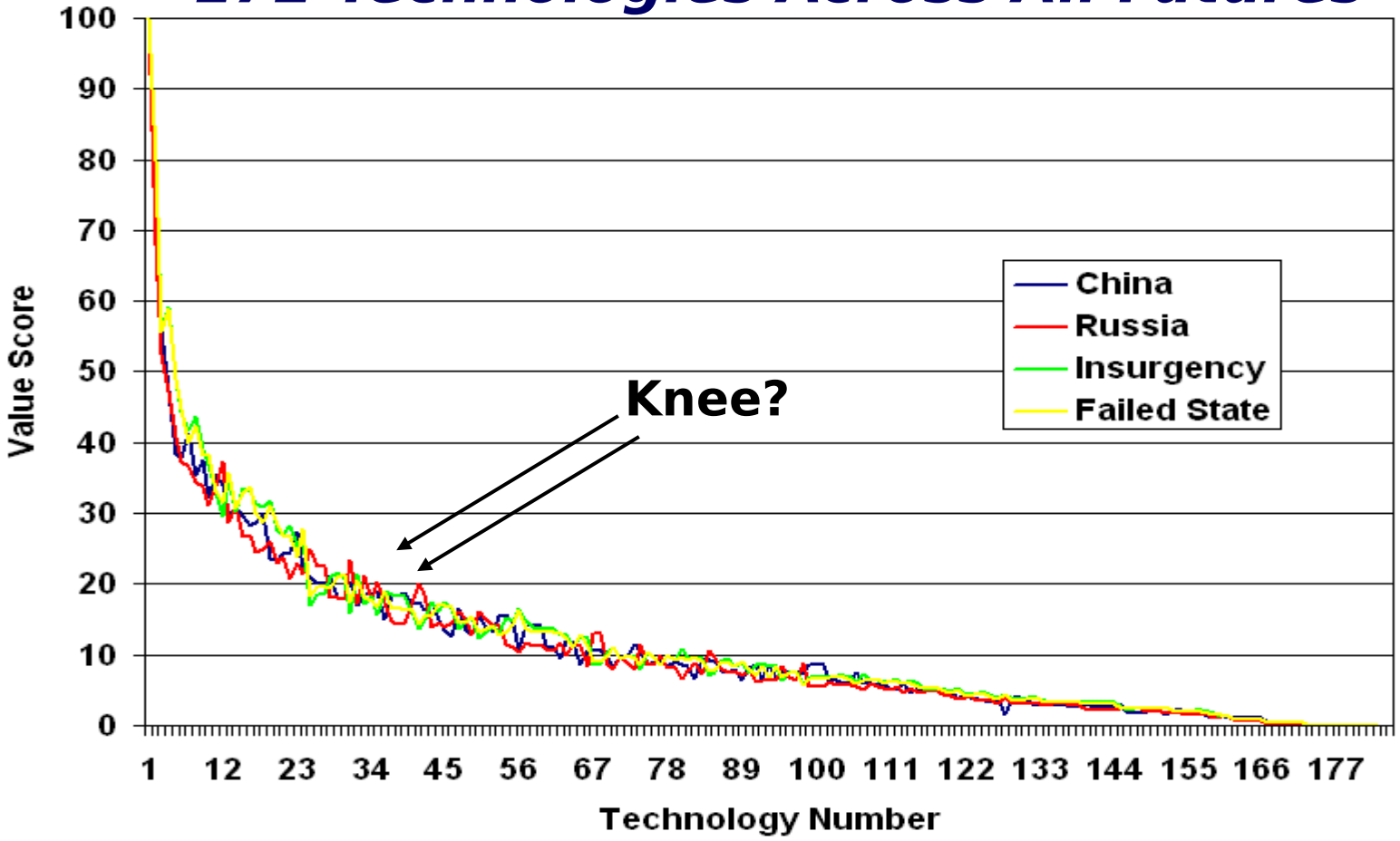
Blue Horizons Summary of Underlying Technologies

Center for Strategy and Technology
Air University, Maxwell Air Force Base, Alabama

Today's Vision – Tomorrow's Capabilities

Evaluating Technology Scores

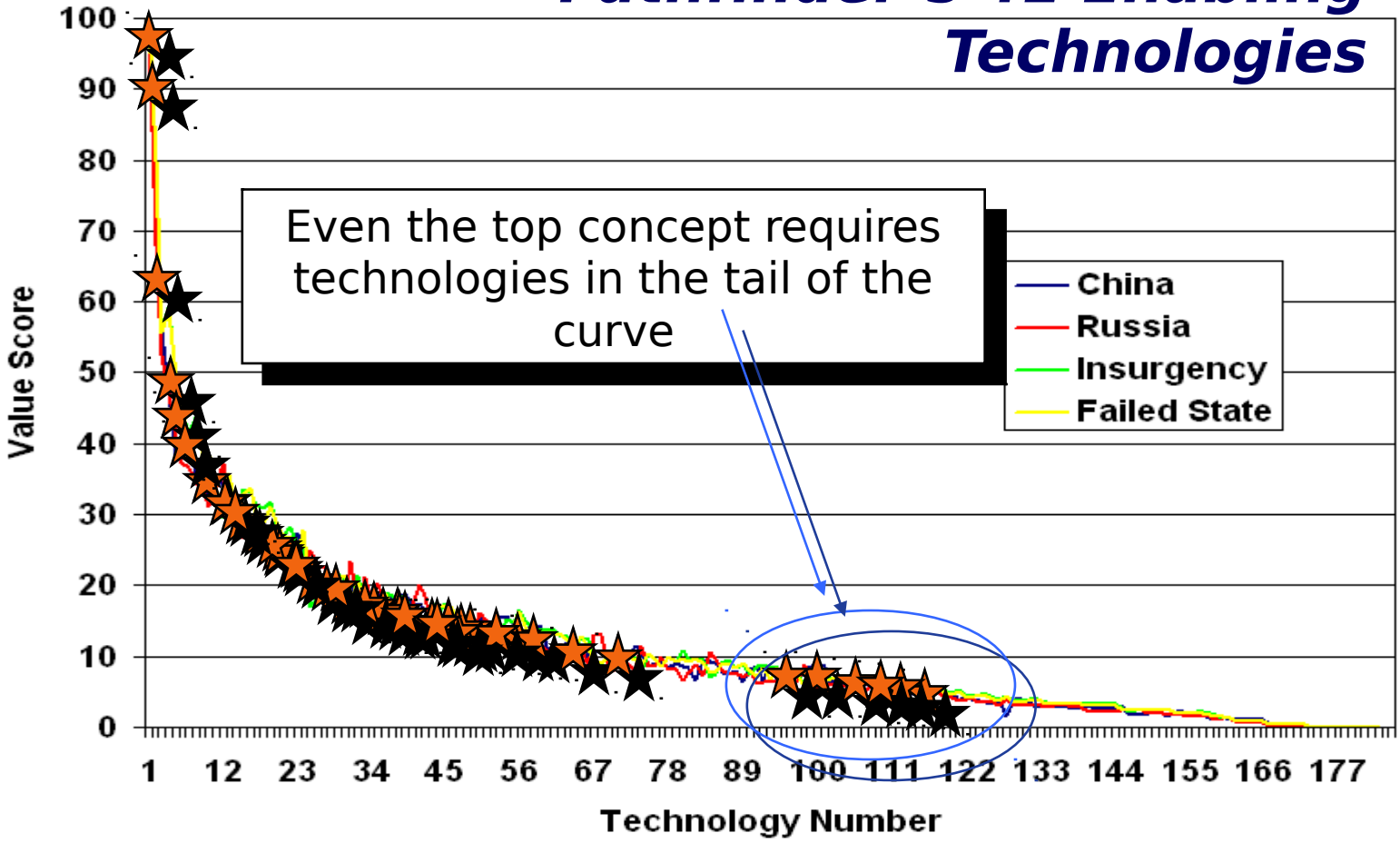
172 Technologies Across All Futures



While there appears to be a "knee" in the curve…

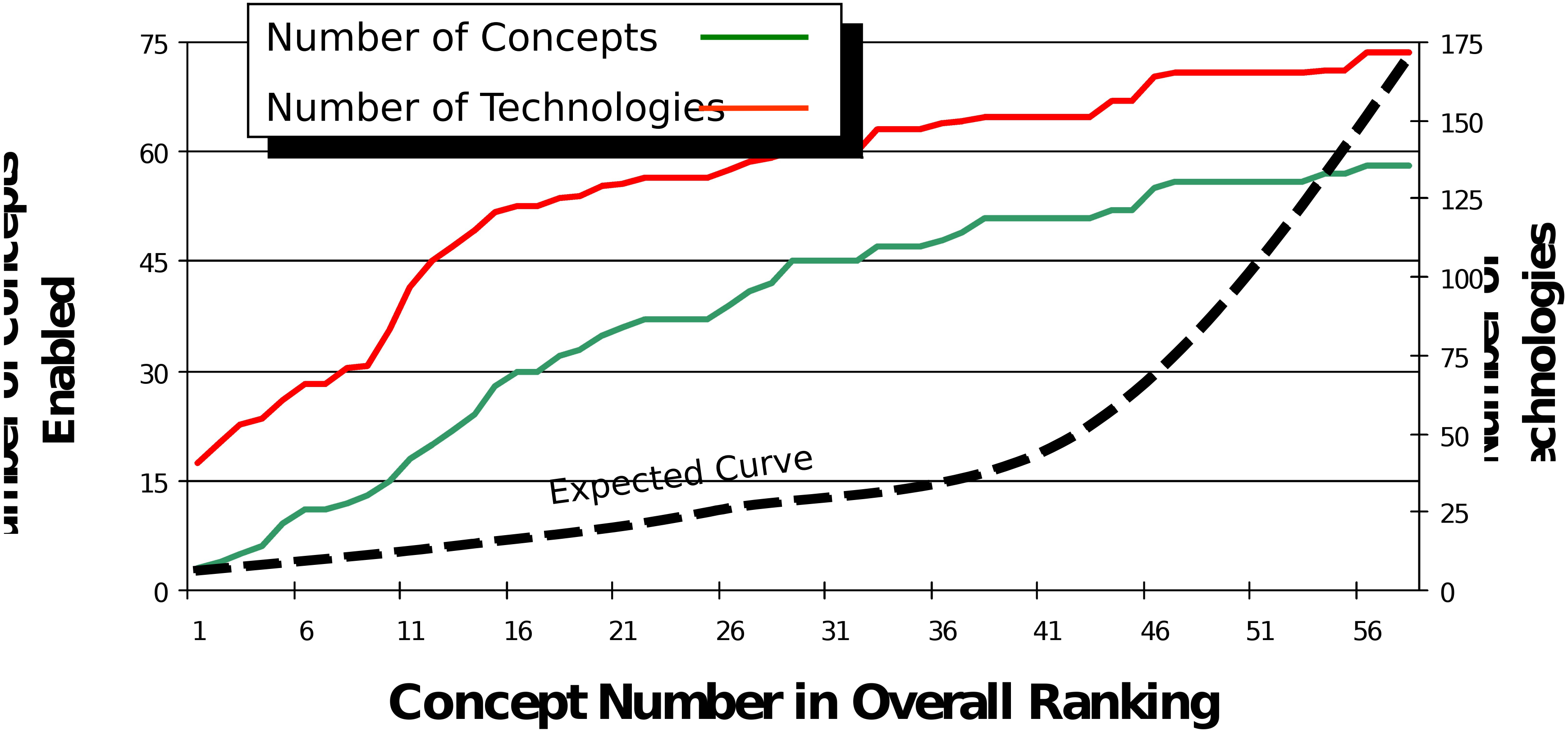
Evaluating Technology Scores

Pathfinder's 41 Enabling Technologies



57 of 58 Concepts Require Technologies in the Tail of the Curve

Number of Technologies and Concepts Enabled By Rank Order



Implied Task: ***Determine how we can leverage a targeted investment today to position the USAF to address a broad set of possible challenges in 2030***

There is no silver bullet -- the future requires a robust S&T investment strategy

Top Technologies

Prioritized Technology Categories

Enabling Technology Category	# Technologies
Assured Communications	4
Auto Track/Sense	9
Vehicle Self Defense	8
Assured Navigation	12
Cyber Protect/Attack	17
Data Fusion/Analysis	6
Laser Optics/Beam Technologies	8
Engine Technologies	7
UAV C2	4
Structures & Materials	4
Space Launch/Ops/Forecast	6
Nuclear Cleanup (supports UAV)	1
Power Generation/Storage	3
High Speed Weapons	3

Additional 2008 Findings and Conclusions

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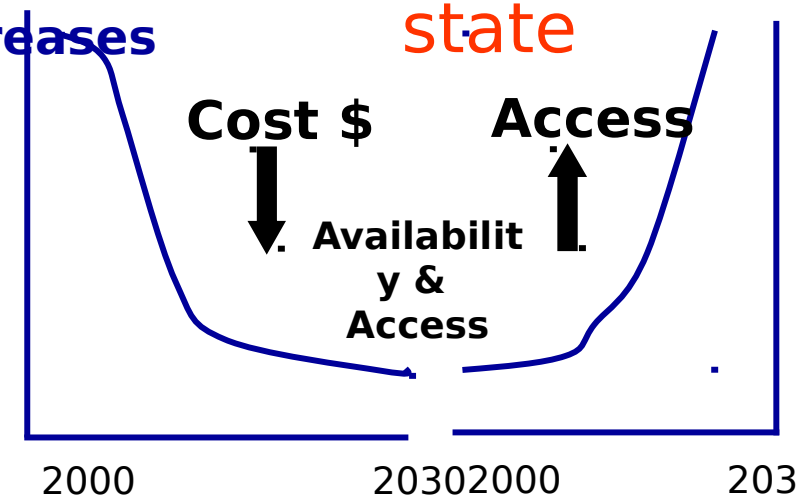
Air University, Maxwell Air Force Base, Alabama

Today's Vision – Tomorrow's Capabilities

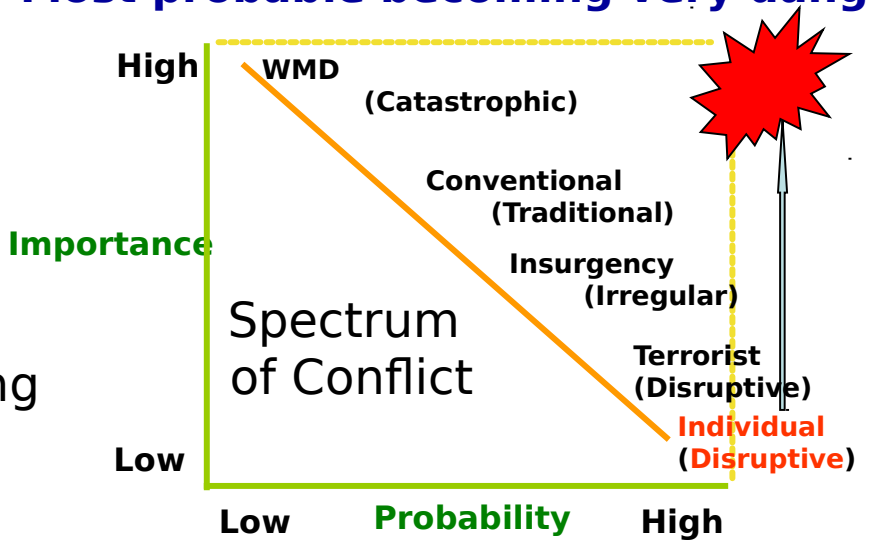
The Study Reveals

- Impact of exponential change in S&T
  - Individual accrues power of the state

Cost of tech decreases – availability increases



Most probable becoming very dange

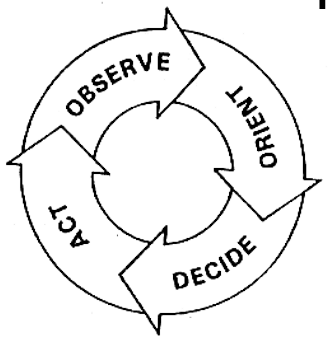


Bottom Line

- Strategic environment for S&T changing rapidly:
- Globalization levels playing field
- Reduced cost of access
- Empowered non-traditional acters

The Study Reveals

- "OODA-loop" shrinks toward an "OODA-point"
  - 2008 – Human commands throughout
  - 2030 – Machines will execute human intent at machine speeds.



  - Human remains in the loop, but in new role
    - Will reigns supreme
    - Programs, builds, integrates, repairs, and analyzes
  - Time between observation and action in tactical engagements will be measured in fractions of seconds
  - Decisions, based on human intent, will be made by machines at machine speeds

Contest of Human Wills . . . Machine Controls Engagement

The Study Reveals

- Increased role for unmanned systems
  - Five of top 10 systems are unmanned or CONUS-based
- Increased importance of the cyberspace domain
  - Need to be able to navigate, explore, defend, and attribute attack in this domain (e.g., Cyberspace UAV)
- Increased need for rapid attack capability
  - Only one of top 10 systems attacks at speeds below Mach 1
- Increased need for survivability – threats proliferate
  - Many of top-ranked technologies are related to defense against directed energy (lasers and HPM) or cyberspace attacks
  - Defensive systems are critical to maintain freedom of action
  - Must be able to defend, reconstitute AND operate while degraded

The Study Reveals

- Rank ordering of concepts and technologies does NOT vary significantly between state-on-state and irregular warfare

- Offensive and defensive space systems and technologies are more crucial in state-on-state warfare than in other types of conflict

Harsh Realities

- Bureaucracy and innovation are incompatible
  - Hierarchy needs to become a more net like structure

- "Bubba Einstein" will have disruptive power

- "OODA-Loop" shrinks toward an "OODA-Point"
  - Surprise is the norm
  - Decreases value of leaders gifted in crisis management; increases value of leaders who can anticipate crises and mitigate effect

- Classical military PME curricula does not prepare leaders for the worlds of 2030

- Recapitalization must include capabilities for the worlds of 2030

Study Recommendations

- Pursue concepts with increased range and persistence
- Increase UAV investments – 5 of top 10 concepts are UAVs
- Develop counters to directed energy – DE threatens all
- Increase emphasis on defensive capabilities because:
  - Technological proliferation is closing the capability gap between the US and its adversaries – individuals and states
  - Adversary systems threaten USAF freedom of action -- greatest impact is in cyber and space
- Improve speed and effectiveness of acquisition process
  - Old issue…but speed of technological development is accelerating
  - Near-action essential to keep pace with adversaries
- Treat cyberspace as a geographic territory in which wars will be fought

Implications for Asia

- Taiwan an issue only…
  - If China destabilizes from within
- If Terror Spreads
  - Observation is key
  - Piracy (Straits of Malacca) May become Linchpin in Local War on Terror
    - Possible Source of Terrorist Revenue
- Science and Technology Underpin Everything
  - Source of Asian Tiger Economic Growth
  - Disinvestment in S&T Results in Foreclosure of Future Options

Implications for Asia

China will Rise to Superpower Status in early 2030s

- India will likely Supplant China as Asia's Greatest Power in 2050-2070 Timeframe
  - Greater Population
  - Democratic Governance will likely Result in Eventual Higher per capita GDP
  - Pakistani-Indian Relations are a Potential Wildcard
- Two Great-Power Transitions in next 50 Years
  - Hegemonic Transition Theory Suggests a Risk of Instability

Questions?

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